#10

Drawings

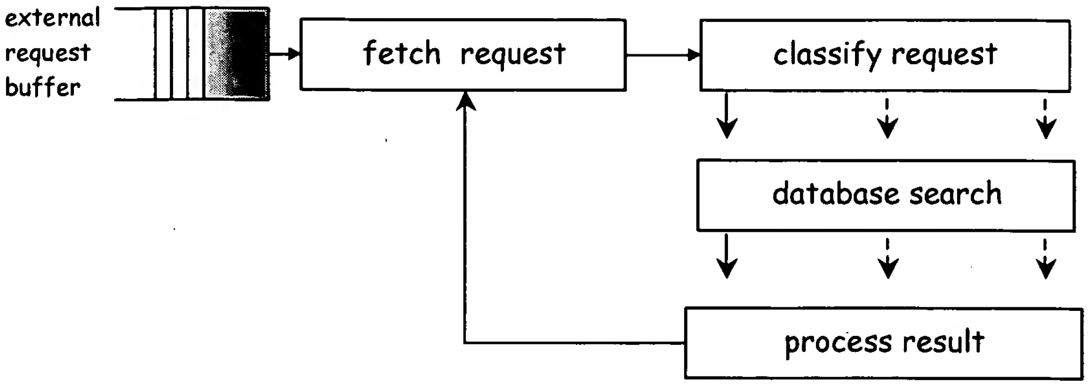


Figure 1: Transaction Processing System (Prior Art).

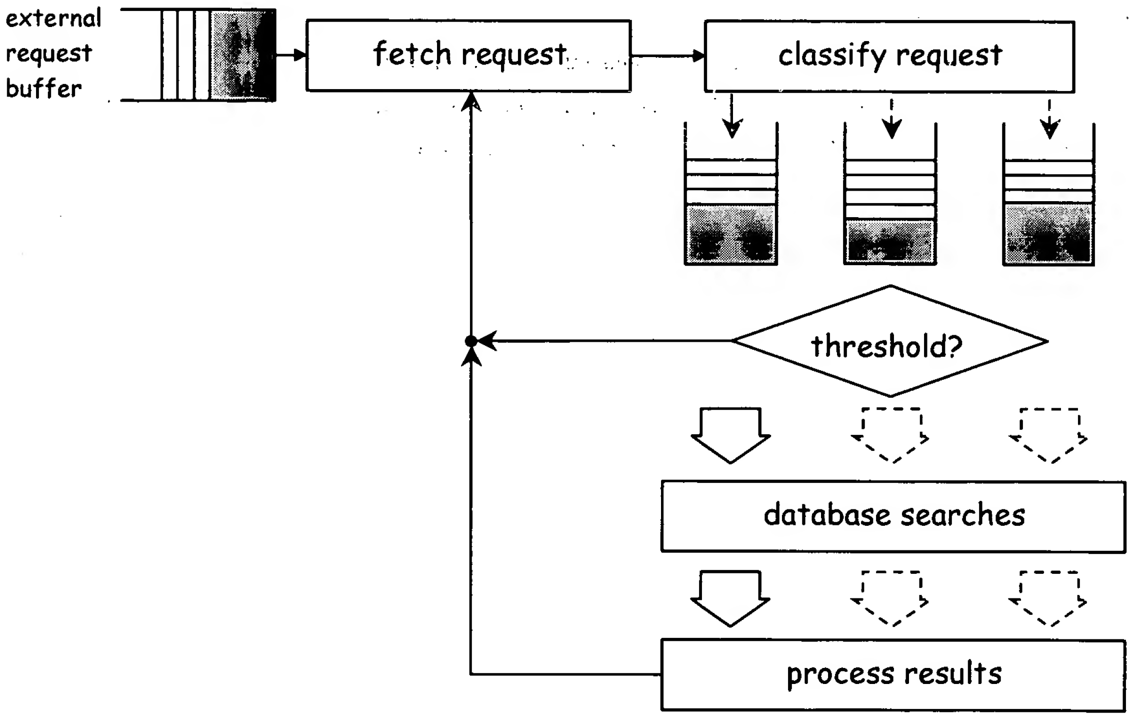


Figure 2: Transaction Processing System with Request Buffering.

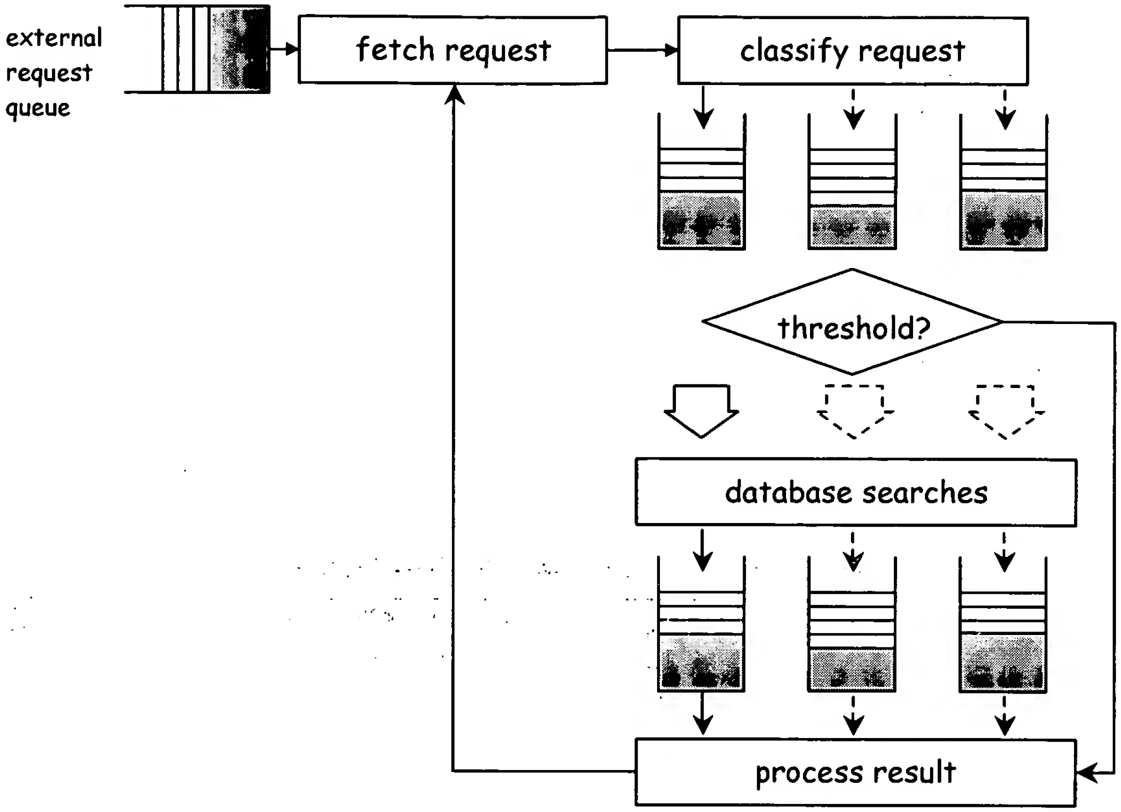
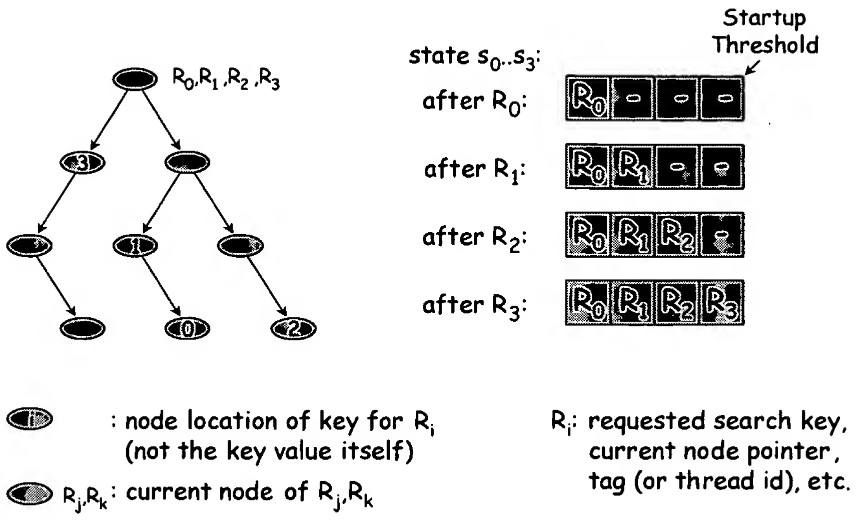


Figure 3: Transaction Processing System with Request and Result Buffering.

First Set of Search Requests



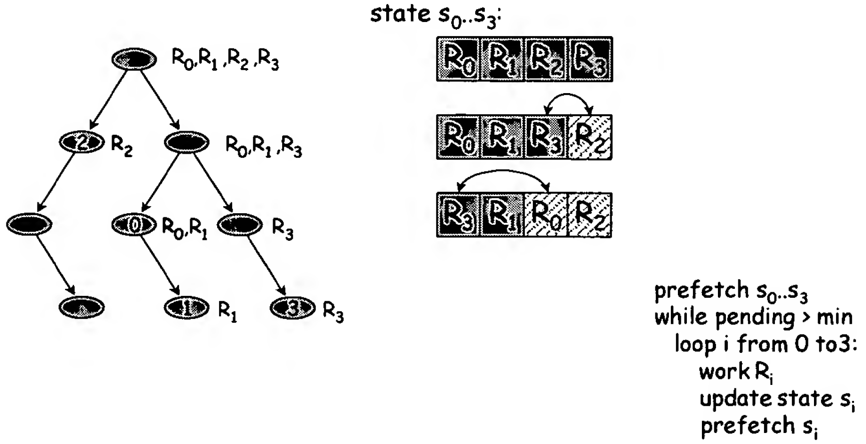
i : node location of key for R_i (not the key value itself)

R_j,R_k : current node of R_j,R_k

R_i: requested search key, current node pointer, tag (or thread id), etc.

Figure 4: Example of a tree traversal buffering.

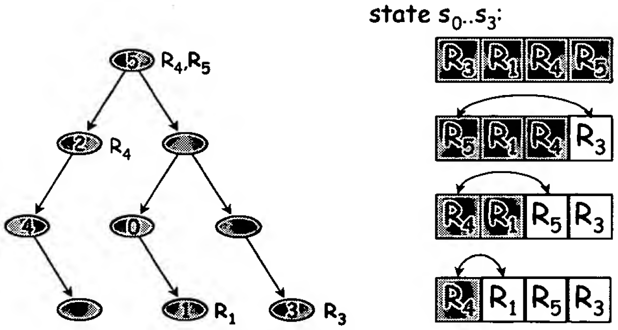
First Pipelined Search



```
prefetch $s_0..s_3$
while pending > min
  loop i from 0 to3:
    work $R_i$
    update state $s_i$
    prefetch $s_i$
```

Figure 5: Example of a pipelined tree search traversal.

Second Pipelined Search



R_3 R_1 R_4 R_5

R_5 R_1 R_4 R_3

R_4 R_1 R_5 R_3

R_4 R_1 R_5 R_3

```
prefetch $s_0..s_3$
while pending > min
  loop i
    work $s_i$
    update state $s_i$
    prefetch $s_i$
```

Figure 6: Example of a pipelined tree search traversal state.

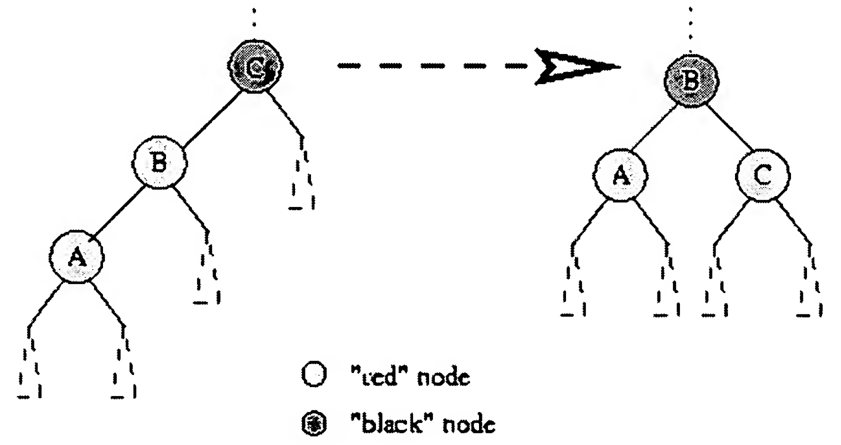


Figure 7: Red-Black Tree Insertion.

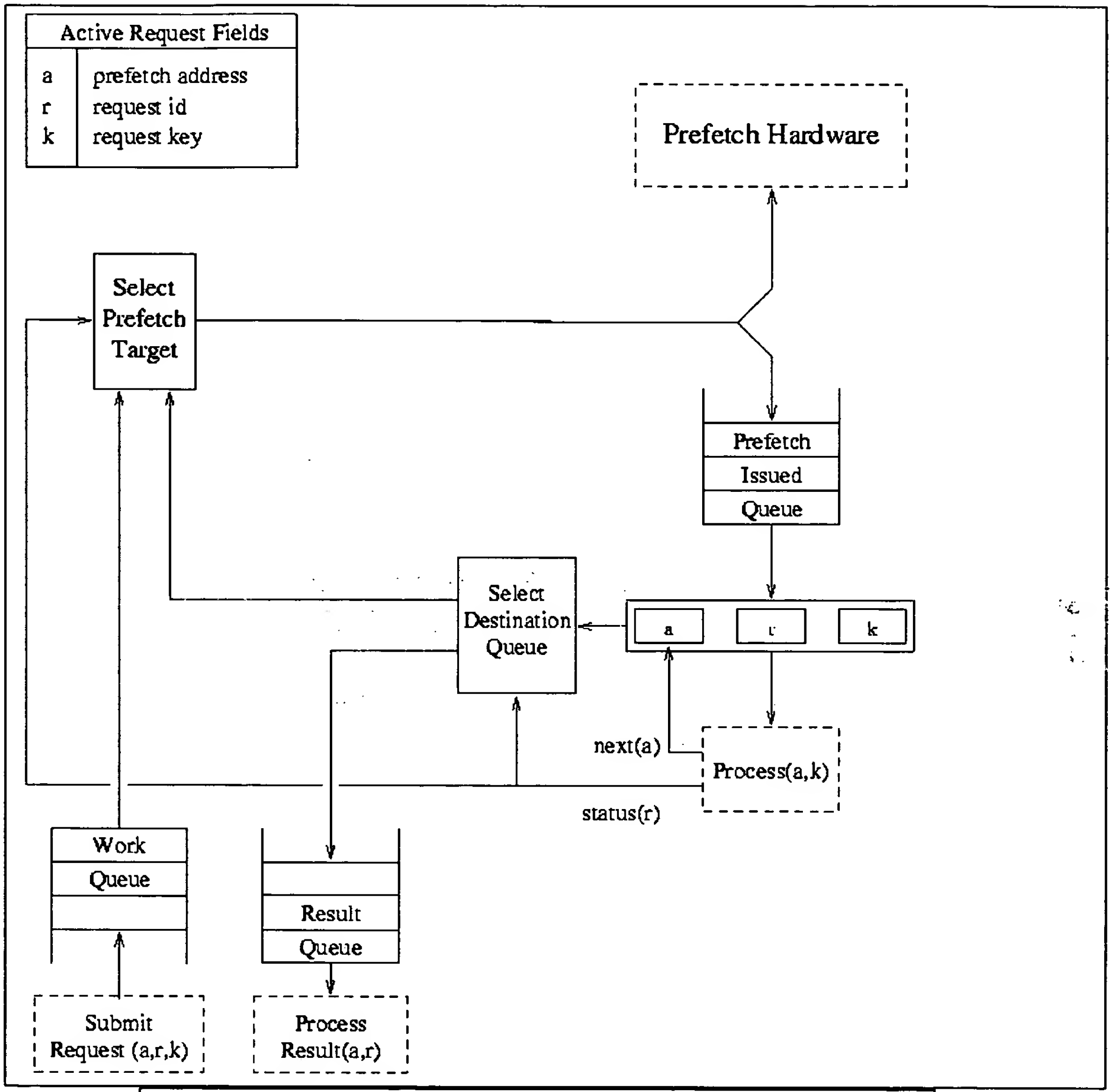


Figure 8: Restructuring mechanism, as implemented in software.

```
RESTRUCTURED-TRAVERSAL( S, request )
begin
        AQ.enqueue( request );
        if $AQ.size \ge K$ then
                SOFTWARE-PIPELINE( S, AQ, RQ );
        if $RQ.size = 0$ then
                return POSTPONE
        else
                return RQ.dequeue()
end
```

Figure 9: Accumulating K requests on accumulation queue AQ for software pipelined traversals of data structure S, where K is the startup threshold. Accumulated results are turned from result queue RQ.

```
TREE-DELAYED-SEARCH( lower )
begin
        integer i, prologue;

        prologue ← MIN(lower, RQ.size);
        $i \leftarrow 0$;
        while $i < prologue$ do
                PREFETCH( RQ.elem[i] );
                $i \leftarrow i + 1$;
        end while
        TREE-RECURSIVE-SEARCH( lower );
end
```

Figure 10: Recursive search requests, initial pre-recursive component.

```
TREE-RECURSIVE-SEARCH( lower )
begin
        $i \leftarrow 0$;
        while $i < AQ.size$ do
                request ← AQ.elem[i];
                k ← request.key;
                n ← request.node;
                if $n$ = NIL or $k = n.key$ then
                        AQ.delete( request );
                        RQ.enqueue( request );
                else
                        if $k < n.key$ then  request.node ← n.left;
                                     else  request.node ← n.right;
                        endif
                        PREFETCH( request.node );
                endif
                $i \leftarrow i + 1$;
        end while
        if $AQ.size \geq lower$ then TREE-RECURSIVE-SEARCH( lower ); endif
end
```

Figure 11: Recursive search requests, recursive component.

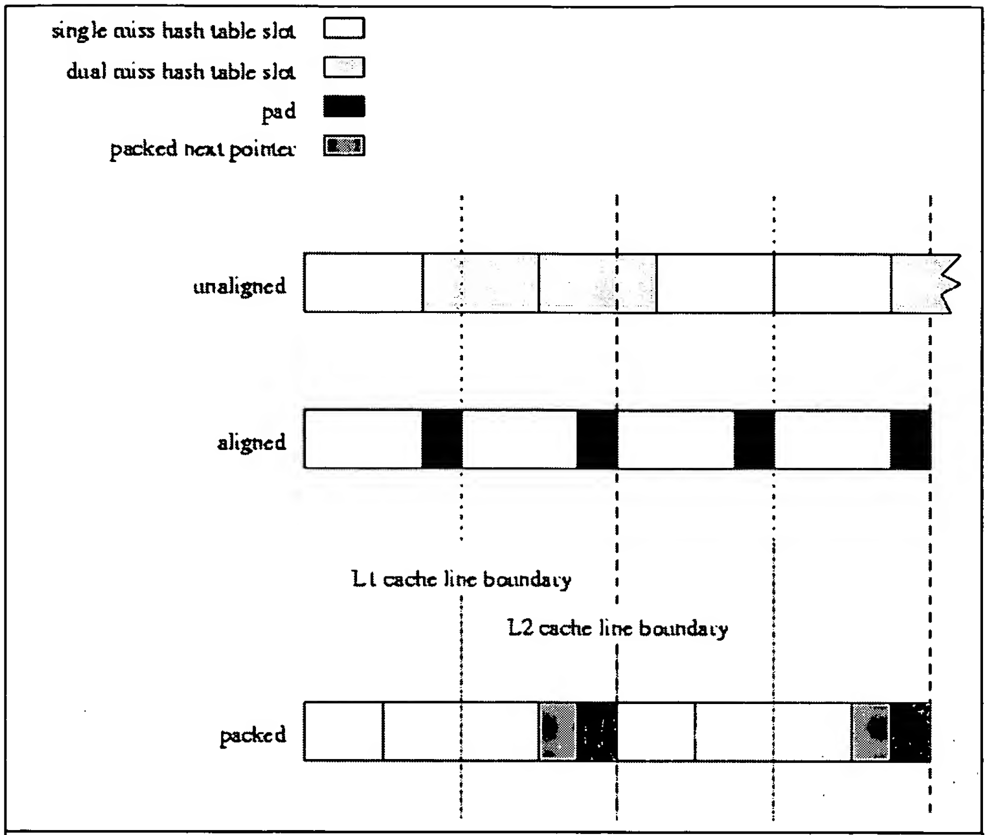


Figure 12: Alignment of Hash Table entries on cache line boundaries.

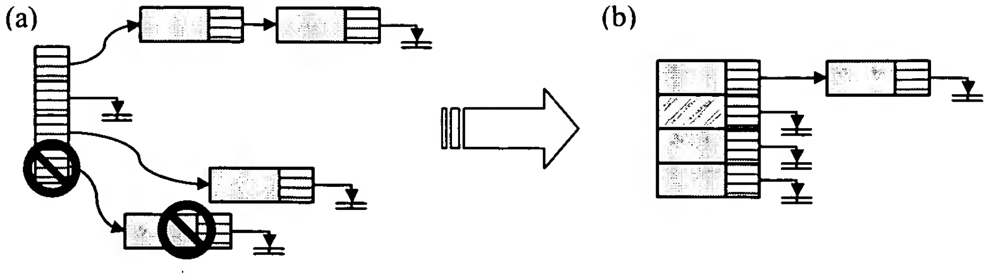


Figure 13: Hash Table homogenezation.

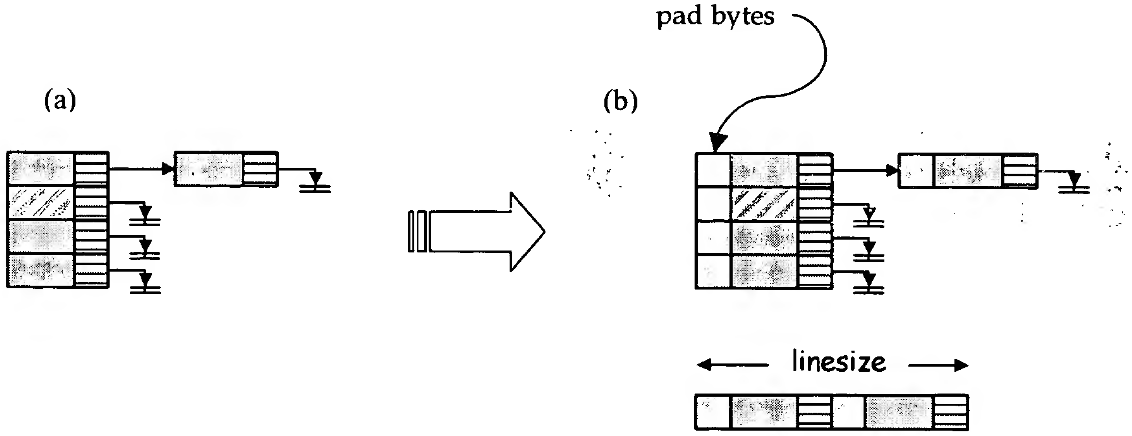


Figure 14: Hash Table padding.

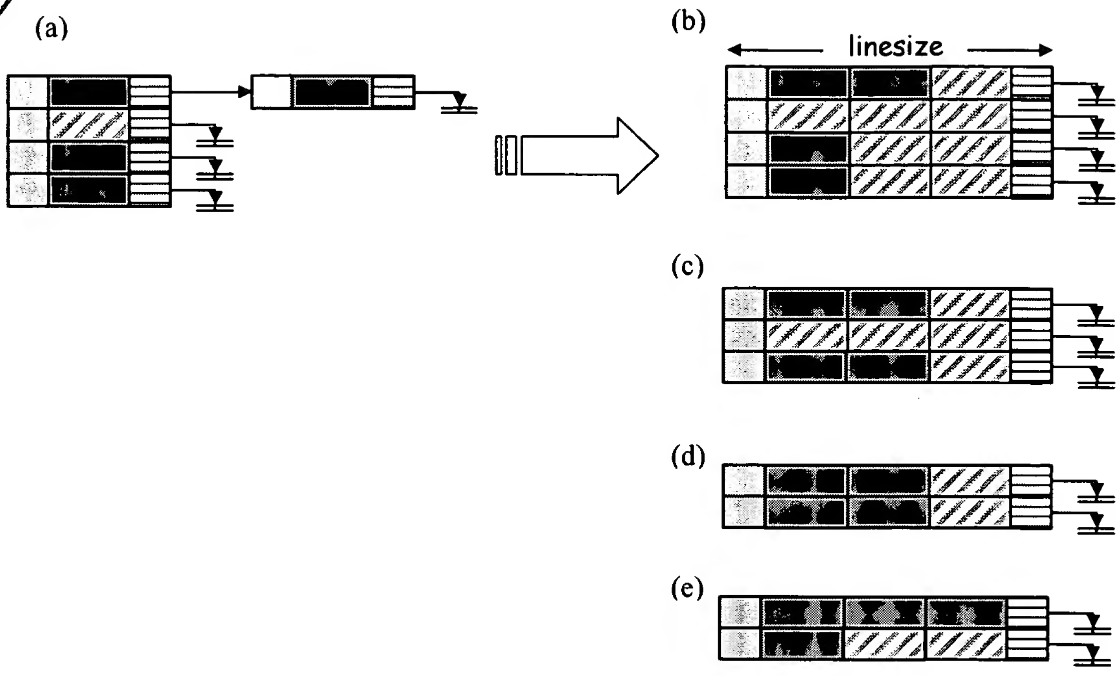


Figure 15: Hash table packing. Representing a homogeneous hash table structure (a) as a packed structure (b), which can be re-balanced to make the table less sparse as in (c), (d), or (e).

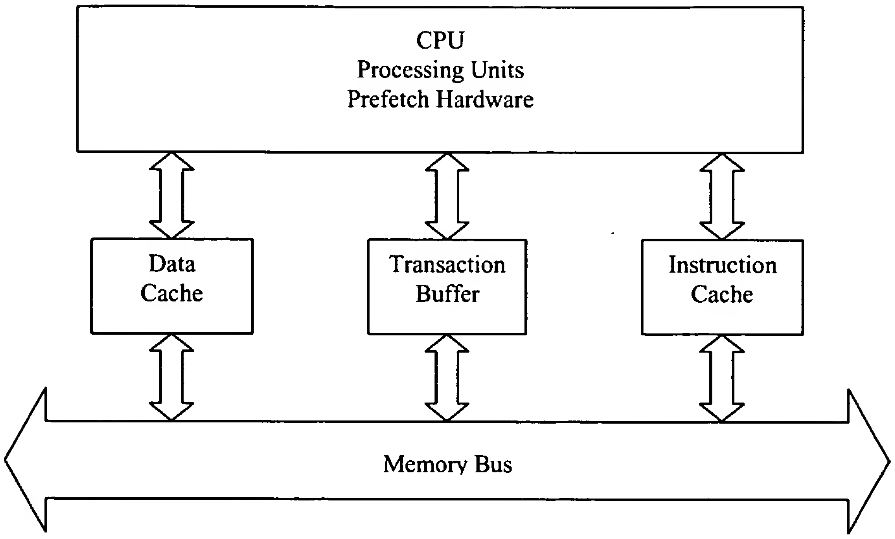
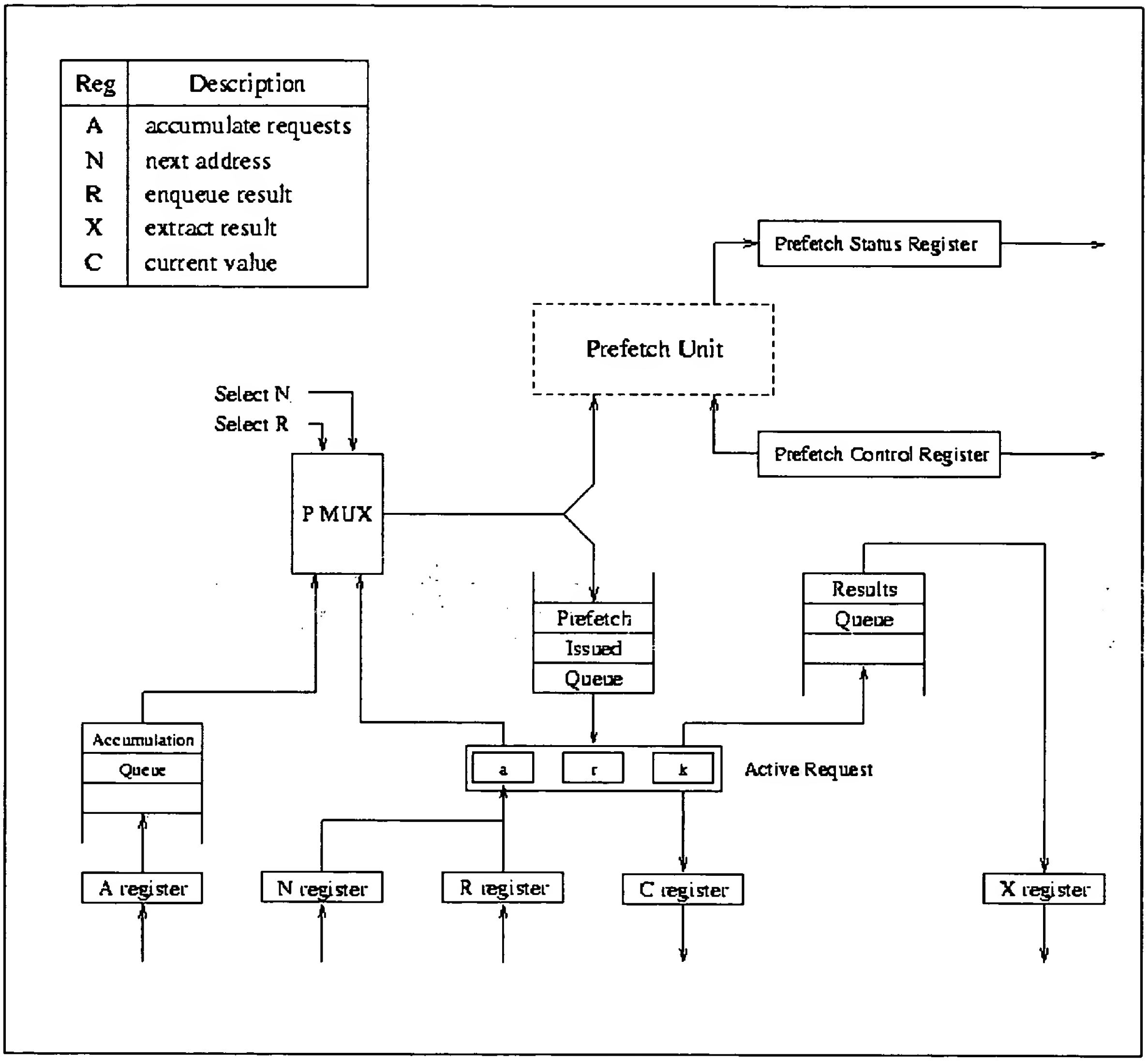


Figure 16: Transaction Buffer.



Reg	Description
A	accumulate requests
N	next address
R	enqueue result
X	extract result
C	current value

Figure 17: Transaction Buffer Details, single set of queues.